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$$=\frac{\cos\alpha-a\cos(\alpha-\beta)}{1-2a\cos\beta+a^2}\ldots.(1),$$

if $n$ be indefinitely increased. Make $\alpha=0$. Then

$$1+a\cos\beta+a^2\cos2\beta+\ldots.a^{n-1}\cos[(n-1)\beta]=\frac{1-a\cos\beta}{1-2a\cos\beta+a^2}\ldots.(2).$$

Multiply (2) by 2 and subtract a unit from both members of the resulting equation, then

$$\frac{1-a^2}{1-2a\cos\beta+a^2}=1+2a\cos\beta+2a^2\cos2\beta+\ldots.2a^{n-1}\cos[(n-1)\beta]\ldots.(3).$$

$$\text{Then, }\int_0^\pi\frac{\cos rx dx}{1+2a\cos x+a^2}=\int_0^\pi\frac{\cos rx}{1-a^2}\{1+2a\cos x+2a^2\cos2x+\ldots.$$

$$+2a^{n-1}\cos[(n-1)x]\}dx=\frac{2a^r}{1-a^2}\int_0^\pi\cos^2rx dx=\frac{\pi a^r}{1-a^2},$$

the terms of the series but this one vanishing between the given limits, as may be seen after reducing for a few terms.

Also solved by *G. B. M. ZERR*, *W. W. LANDIS*, *J. SCHEFFER*, and *L. C. PLANT*.

107. **Proposed by F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics and Astronomy in Irving College Mechanicsburg, Pa.**

The speed of signaling in submarine telegraph-cable varies as $x^2\log(1/x)$, in which $x$ is the ratio of the radius of the core to that of the covering. Prove that the *maximum speed* is attained when this ratio is $1:\sqrt{e}$.

I. **Solution by J. W. YOUNG, Cornell University, Ithaca, N. Y.; COOPER D. SCHMITT, A. M., University of Tennessee, Knoxville, Tenn.; and G. B. M. ZERR, A. M., Ph. D., The Temple College, Philadelphia, Pa.**

$$\text{If } y=x^2\log\left(\frac{1}{x}\right)=-x^2\log x,\quad \frac{dy}{dx}=-2x\log x-x=-x(\log x^2+1).$$

$\log x^2+1=0$ gives the maximum.

$$\therefore\ \log\frac{1}{x^2}=1.\quad \therefore\ \frac{1}{x^2}=e,\text{ and } x=\frac{1}{\sqrt{e}}.$$

II. **Solution by H. C. WHITAKER, Ph.D., Manual Training School, Philadelphia, Pa.; W. W. LANDIS, A.M., Dickinson College, Carlisle, Pa.; J. O. MAHONEY, B. E., M. Sc., Central High School, Dallas, Tex.; ALOIS F. KOVARIK, Decorah Institute, Decorah, Ia.; and J. JCHEFFER, A. M., Hagerstown, Md.**

$$\text{If } S=cx^2\log\frac{1}{x},\quad \frac{dS}{dx}=2cx\log\frac{1}{x}-cx.$$

Dividing by $cx$ and equating to zero, $\log\dfrac{1}{x}=\frac{1}{2}$.

Whence, $\dfrac{1}{x}=\sqrt{e}$, and $x=\dfrac{1}{\sqrt{e}}$.

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## MECHANICS.

**104.** **Proposed by F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics and Astronomy in Irving College, Mechanicsburg, Pa.**

From a locomotive and tender standing still on a bridge, the pressure on the bridged is $p_1=80$ tons. The track is supposed to be straight and practically horizontal. Had the locomotive and tender been running at the rate of $r=60$ miles an hour, how many tons would the pressure on the bridge have been?

**II. Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics. The Temple College, Philadelphia, Pa.**

Regarding the earth as a perfect sphere and neglecting its rotation, we get for latitude, $\theta$.

Centrifugal force$=\dfrac{Wv^2}{gR\cos\theta}=f$,

where $W=80$ tons$=160000$ pounds, $v=60$ miles an hour$=88$ feet per second, $g=$gravity$=32.16$ feet, $R=$radius of earth$=3956$ miles$=20887680$ feet.

$\therefore f=\dfrac{1239040000}{671747788.8\cos\theta}=\dfrac{1.8445}{\cos\theta}$ pounds.

If the locomotive is running on a great circle, $f=1.8445$ pounds.

$P=$pressure$=W-f=159998.1555$ pounds.

$\therefore P=79.99908$ tons, or practically 80 tons, the original weight.

**105.** **Proposed by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.**

Let $2a$, $2b$ be the diagonals of a rhombus, $\varphi$ the angle the principal axis at the mid-point of a side makes with the diagonals. Prove $\tan2\varphi+\frac{3}{5}\tan\beta$, when $\beta$ is an angle of the rhombus. The principal moments of inertia about this mid-point of the side are $\frac{1}{24}m\{5a^2+5b^2\pm\sqrt{[25(a^2+b^2)^2-64a^2b^2]}\}$.

**Solution by the PROPOSER.**

Let $ABCD$ be the rhombus, side $c$. $EF$, $FB$ the axes; $\angle DAB=\angle EFB=\beta$; $\angle\theta=$the angle the principal axis makes with the side $AB$ at its mid-point $F$; $\angle\varphi$, the angle the principal axis makes with the diagonal.

$$\text{Then }\Sigma mxy=\rho\sin^2\beta\int_{-\frac{1}{2}c}^{\frac{1}{2}c}\int_0^c(x+y\cos\beta)y\,dx\,dy=\tfrac{1}{8}\rho c^2\sin\beta\cos\beta=\tfrac{1}{8}mc^2\sin\beta\cos\beta.$$

$$\Sigma mx^2=\rho\sin\beta\int_{-\frac{1}{2}c}^{\frac{1}{2}c}\int_0^c(x+y\cos\beta)^2\,dx\,dy=\tfrac{1}{12}m(c^2+4c^2\cos^2\beta).$$